

Mammals  
of  
The National Parks of Haiti

by

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The Mammals  
of  
Parc National La Visite  
and  
Parc National Pic Macaya  
Haiti

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## Introduction

The current mammalian fauna of the mountains of Haiti differs from the much more diverse assemblage of mammals that existed at the time indians first arrived on the island 4500-7000 years ago (Rouse and Allaire, 1978), or even at the dawn of the colonial era when Columbus discovered Hispaniola in 1492 (Miller, 1929; Woods et al., 1986). A journey through either of the national parks today reveals few signs or sightings of mammals other than domestic species. The most common indigenous mammals of Haiti today are bats. The endemic terrestrial mammals of the parks that still survive are secretive and predominantly nocturnal, which further leads to the impression of a landscape largely devoid of native mammals. The purpose of this report is to document the kinds of mammals that were present in the region of the parks before the arrival of indians as well as to discuss the composition of the present day mammalian fauna in and around Parc National La Visite of the Massif de La Selle and Parc National Pic Macaya of the Massif de La Hotte. The exact locations and characteristics of each park are described in Woods and Harris (1986), and are illustrated in figures 1-3 at the end of this report.

## Materials and Methods

The composition of the mammalian fauna present in the region of the national parks before historical times (before 1492) was determined by the analysis of fossil and subfossil specimens collected in sinkholes and caves within the boundaries of the parks. Specimens were identified as bones or bone fragments found in complete sections of matrix that were dug from the floor of caves or sinkholes floors. For each site a grid system was established and all collections were recorded as to the exact and relative positions of the material within the overall grid. Larger bones were collected directly, with the important data such as to location and associated material recorded on the label. Small specimens, fragments and isolated teeth were recovered by sifting the matrix through screens. If the matrix was wet or contained significant amounts of clay the material was washed through the screen. In all cases the data associated with each unit (part of a collection measuring meter x 1 meter x 6 centimeters) remained associated with each fragment or specimen. Identifications were made on the specimens collected by comparing them with known taxa within the collections of the Florida State Museum. Dates were obtained on important specimens by determining the  $C^{14}$  ratio in bone fragments found at the same level and in close association with the specimen in question. The radiometric

dates were done at Beta Analytic Laboratory in Miami, Florida.

Recent land mammals were surveyed along a transect utilizing traps of various designs. The designs were: 1) "Museum Special" snap trap (kill trap); 2) standard rat trap (kill trap); 3) Sherman folding trap - 3"x3"x 9" (live trap); 4) Tomahawk folding wire trap - 6"x6"x 19" (live trap); and 5) Tomahawk folding wire trap - 9"x9"x 26" (live trap). These traps were used in combinations to sample a habitat in such a way that it would be possible to capture small mammals from the size of a mouse (Mus musculus; 10 grams) to a "Zagouti" (Plagiodontia aedium; 1500 grams). The traps were baited with a variety of substances including: 1) sardines; 2) squashed bananas; 3) rolled oats and peanut butter; 4) tuna fish; 5) various combinations of items 1-4. Traps were set along transects that were established in each national park. Each trap was marked with orange surveyors tape placed far enough away from the trap not to be noticed. Traps were set in habitats representing all of the major habitat types in each national park. For each habitat approximately 100 traps were set on two successive nights and throughout the intervening day. For each specimen collected the following information was recorded: 1) species; 2) sex and reproductive status; 3) special morphological features (i.e. color, pelage condition, parasite damage). The trapping data were used to

calculate: 1) the total number of species present for each habitat; 2) the total number of individuals of each species present in each habitat; 3) the percent capture rate for each habitat (number of traps divided by the number of individuals captured); 4) the number of "trap nights" associated with each habitat (trap night = number of traps set x number of nights).

The habitats analyzed were specifically chosen to represent each of the major habitat types in the parks (see description of habitats in Woods and Harris, 1986). For Parc National La Visite I selected the following habitats: 1) mature pine forest ("Bwapen"); 2) successional pine forest ("Bwapen Raje"); 3) mesic broad-leaved forest in large stands ("Rak Bwa"); 4) broad-leaved forest broken into small patches surrounded by open lands ("Bwa Raje"); 5) open areas with small shrubs, ferns or grass ("Raje"); 6) areas along the sides of streams (no creole name). Following each habitat is the Haitian Creole name in quotes with the spelling based on usage in Valdman (1981).

In Parc National Pic Macaya the same six types of habitat were sampled. These habitats form dominant units in the park above 1350 meters. Below 1350 meters the topography of the park is less steep and is characterized by deeply cut plains and exposed limestone. These areas were also sampled. The lowland areas (950-1350 meters) sampled

included: 1) the extensive broad-leaved forests found in association with karst domes or extensive exposures of karst topography (Rak Bwa Woch"); 2) fragments of lowland broad-leaved forest that are associated with small karst domes surrounded by open land ("Bwa Raje Woch"). These areas, along with extensive areas of open pasture and cleared, cultivated fields (which were not sampled), form the dominant habitats of Parc National Pic Macaya on the Plain of Formon and adjacent karst hills. Photographs and maps of all of these habitats are available in Woods and Harris (1986).

The presence, absence and relative abundance of land mammals for each of the habitats discussed above were also established by searching for characteristic mammal remains. Signs and remains that indicate the presence of species of terrestrial mammal include: 1) tracks; 2) indications of feeding activity such as gnawing on plant material; 3) animal parts; 4) nests, burrows or shelters in rock crevices; 5) remains of small mammals in the droppings of larger predators such as dogs, cats or mongoose; 6) remains (usually partial skeletons) of mammals collected at the site where the animals died or were killed (i.e. in rock crevices, small sinkholes or in or near gardens where peasants may have killed the animal); 7) remains of small



mammals collected from owl pellets recovered from caves within the boundaries of the park.

The other major group of mammals surveyed in each park are bats. The presence of some species of bats in a region can be known by analyzing owl pellets from roosting barn owls (Tyto alba). However, barn owls feed over a wide range of habitats sometimes several kilometers from their roost site in a cave and so it is important to demonstrate the presence of bats in a specific region. This can be done by identifying bones of bats found on the floor of caves beneath their roost site. Another, and more precise method is to sample with mist nets set in specific habitats. It is possible to associate a bat species with a precise habitat type using the techniques outlined above. In this study mist nets were set in all of the major habitat types of each park. Nets were left set day and night during the sampling period, and were used to analyze the avian fauna as well as the bat fauna.

Mammalian fauna  
of  
Parc National La Visite

A. Introduction

The survey of the mammals of the Parc National La Visite was concentrated in the core of the park between the summits of Morne La Visite (2170 meters elevation) in the west and Morne Cabaio (2282 meters elevation) in the east and in the regions north and south of the La Selle Escarpment down to 1650 meters elevation (Figure 2). The region has steep cliffs covered with broad-leaved forest north of the ridge (La Selle Escarpment). Pine forest grows in a broad basin of relatively flat habitat south of the ridge. A narrow zone of exposed limestone habitat caps the ridge on which a scrub broad-leaved forest grows. Shallow soils cover Eocene limestone bedrock in most areas of the park. Pine forests (often savannah-like) dominate in exposed regions while a thick broad-leaved forest (sometimes mixed with tall pines) grow in ravines and sinkholes. Deep ravines are associated with streams draining into the Riviere Blanche. These ravines, and the ravine of the river itself with its occasional waterfalls, are covered with dense broad-leaved forests on north facing slopes. Pine forests grow on the south facing slopes of these ravines.

The area of the Parc National La Visite south of the La Selle Escarpment is relatively flat and forms a basin. Water from the region drains centrally into the Riviere Blanche. There are many sinkholes, caves and areas of exposed limestone, often forming craggy zones referred to locally as "kase dans" (broken teeth). The parks are inhabited by peasant farmers who have planted corn in open dry areas, and cleared small garden patches in mesic areas which have been planted in vegetable crops. The La Visite area was logged up until the late 1970s, and many large pines were removed from the plateau at that time. The stumps of these pines are scattered about the region indicating the extent of the deforestation. In some of these areas dense pine stands indicate areas of natural regeneration of the pine forest. The base and bark of most large pines are charred, as is the deep leaf layer just above the soil surface. Fires may have been a major feature in the ecology of the region of the park.

Within the above area, transects were set in each of the locations described below.

#### B. Habitats surveyed in Parc National La Visite

1. The undisturbed broad-leaved forest on the steep north slope 100 meters east of Morne La Visite at 2160 meters elevation ("Rak Bwa").

2. The disturbed broad-leaved forest on the steep north slope 500 meters east of Morne La Visite at 2120 meters elevation ("Bwa Raje -1").

3. The destroyed (cut and burned) broad-leaved forest north of the ridge just below the karst limestone cap 550 meters east of Morne La Visite at 2160 meters elevation ("Bwa Raje -2").

4. The upper plateau of open pastures and ruinate scrubby vegetation located near the ridge at 2150 meters elevation 900 meters east of Morne La Visite and 100 meters SW of Tete 2187 ("Raje").

5. The pine forest in a ravine 500 meters south of the ridge and Tete 2187. The pine forest has a stream located in the bottom of the ravine and the elevation averages 2100 meters ("Bwapen").

6. The broad-leaved forest patches along a ravine of the Riviere Blanche 3.2 km south of Morne La Visite at an elevation of 1730 meters ("Riviere Rak Bwa").

7. A successional pine forest near a stream north of the old sawmill ("La Scierie") at 1940 meters elevation. The area is near the road through the

park, and several houses ("Bwapen Raje").

### C. Recent Land Mammals of Parc National La Visite

A. The mongoose, Herpestes auropunctatus, occurs in all areas of the national park up to the ridge of the massif at 2187 meters elevation in open Raje areas. One mongoose was captured near the ridge in a Tomahawk live trap set at the edge of a pasture near a patch of brush. Previous sightings of the mongoose in Parc National La Visite are: 1) near Morne La Visite at 2000 meters in May 1982 in a brushy stream bed ("Riviere Rak Bwa"); 2) in the pine forest ("Bwapen") near La Scierie (1920 meters elevation) in September 1983; 3) near a sinkhole named Trou Jean Paul (1800 meters elevation) in May 1983 and; 4) in a successional pine forest ("Bwapen Raje") near Morne La Visite (2000 meters elevation) in January 1984. These observations indicate that the mongoose can be found in both open and forested areas throughout the park. Few mongoose were captured or seen during the course of the study. In January 1985 a team of 15 biologists worked in an open "Raje" area of the park for 1 week and did not see any mongoose. The density of the mongoose in Parc La Visite is assumed to be low, and it appears as if the mongoose is in the process of expanding its range into the park as a result of habitat modification and the presence of artificial food

supplies such as domestic fowl that are associated with human presence in the area. It is not clear what the effect of increased numbers of mongoose in the parks will be on the fauna. Birds such as the Greater Antillean Bullfinch and Killdeer which nest on or near the ground are especially vulnerable to predation by the mongoose, as are small ground dwelling reptiles. The mongoose is also capable of disturbing breeding Black-capped Petrels if the increased number of gardens on the north face of the ridge of La Visite allow the mongoose to gain access to the burrows of these birds. An active program of mongoose control is now underway in Hawaii in an effort to reduce the numbers of these mammals in critical habitats for nesting birds (Keith, et al., 1985).

B. The House mouse, Mus musculus is found in areas of the park that are near water and where pine forest provides cover and a deep layer of pine needles on the forest floor. The mice captured during the study came from one area of the park in the pine forest near a stream that was far away from the nearest house and agricultural area. A possible explanation for the presence of mice in this well forested habitat is that the forest was previously cut and burned, and the mice became established in the region when more ruinate conditions prevailed. Pines in the immediate area where the mice were captured were two to five meters in

height and the forest was at an early successional state. Mice were also found near a stream adjacent to the old sawmill (La Scierie) in an area of mature pine forest. House mice are often seen in ajupas and around houses in the park, but are generally not found in areas of natural vegetation, unlike rats which are found in all of the habitats sampled in the park.

C. Norway rats, Rattus norvegicus, were not collected in the La Visite area during the sampling period, in spite of trapping in several areas of heavy forest cover and deep leaf litter as well as around houses.

D. Black rats, Rattus rattus are abundant in all regions of the park during the inventory period no matter what the local conditions were. Four distinct morphotypes are present in the park (Table 1):

1) uniformly brown; 2) brown with a white belly; 3) black with a grey belly; 4) black or grey with a white belly.

Areas of pine habitat have a higher incidence of brown and brown and white morphotypes. Rattus rattus is now abundant in the Bwa Rage habitat near the crest of the ridge which two years ago was populated with Plagiodontia aedium, and which had a more substantial forest cover at that time. Two years ago few rats were collected in the area, so rats appear to have moved into the habitat previously occupied by Plagiodontia. Several rats were trapped at the mouth of rock crevices previously occupied by P. aedium.

It is not clear why no Norway rats were found in the park, and why Black rats dominate. Where Norway and Black rats are found together the more aggressive Norway rat will usually replace the Black rat, especially in mesic habitats. The more arboreal Black rat is most likely to be found in drier areas, and in areas with tree cover (especially palm trees and in the thatch of houses, where its common name, "Roof rat", indicates it is frequently observed. Both species of rat are abundant in lowland areas to the north and south of the park. Black rats are reported to damage coconuts and cacao pods in the Barahona region to the east and at Fond des Negres Experiment Station to the west. Norway rats are common in the Port-au-Prince area as well as the Plain of Cayes and is the dominant species in the rice fields of the Artibonite Valley. Norway rats are known to feed on corn in the Port-au-Prince area (Bruggers and Valvano, 1983). In one study sponsored by USAID and conducted by MARNDR in 1983 1.9 percent of the corn crop was damaged in April while damage increased to 18 percent in December (Keith, personal communication). These figures indicate that Norway rats were abundant in lowland areas where corn was grown during the same period as the present study was underway. Since the region around Parc National La Visite is now widely planted in corn, it is possible that the habitat in the La Visite region is being made more attractive to Norway rats, and that both rat species will be



found in the park in the future. Since Norway rats favor more mesic areas and are more terrestrial in habit, it is likely that this species will have a more negative impact than the Black rat on the Black-capped Petrels breeding on the north facing cliffs of the park.

E. The "Zagouti", Plagiodontia aedium, is no longer abundant within the park. No specimens or signs (pellets, scent markings, chewed bark) of P. aedium were found in the pine forest or in open disturbed areas near the ridge (Raje). In 1985 only one P. aedium was found in the area of the cool wet forest north of the ridge (Rak Bwa). This is especially disturbing since I estimate that twenty five P. aedium were found in this same area along the ridge (2150 meters elevation) in 1980-1982. The forest there has been largely cut in the last three years to make gardens. The P. aedium have steadily disappeared. In January 1985 the only sign of P. aedium found along the north face of the ridge was a single freshly chewed tree branch. The apparent reasons for the reduction in numbers of the "Zagouti" are:

1. Loss of habitat by burning and cutting to make space for temporary gardens.
2. Animals killed by peasants working in their gardens (one specimen was found dead with its head cut off at the edge of a new garden on 29 May 1982).

3. Animals killed by dogs (bones of P. aedium were found in feces of two dogs).

The increase in the number of rats in the above areas appears to be associated with the decline in the number of P. aedium, but it is not clear if the phenomenon is a cause or an effect. It is therefore not possible to conclude that the increase in the number of Black rats caused the reduction in numbers of P. aedium or whether habitat loss and predation reduced the number of P. aedium and made the habitat more available to rats.

Plagiodontia aedium is still present in low numbers within the boundaries of the park along the margins of the Ravine de la Riviere Blanche (1730 meters). Numerous signs (pellets, chewed bark or pine trees) of P. aedium were found within the ravine near areas of exposed limestone and in crevices suitable as shelter.

F. Solenodon paradoxus, which does not have a common name but is sometimes called "Zagouti" or "Nez Longe ", does not appear to occur in the park. No specimens were found, and no feces of the species were located. Cone shaped diggings similar to those made by Solenodon were observed in Bwa Raje habitats near the ridge, but appear to have been made by Rattus rattus, which was abundant in the habitat. An analysis of bony remains collected in sinkholes within the boundaries of Parc La Visite (Table 3) indicates that S.

paradoxus was common in the area until recent times. I believe that feral dogs have killed all of the Solenodon that once lived in the area. The one area close to the park where the density of feral dogs and cats is low and where an extensive area of wet broad-leaved forest still exists is Morne d'Enfer. I recommend that Morne d'Enfer be included in the park.

G. The domestic cat, Felis catus, is feral within the boundaries of the park where it is known as "chat mawon". No cats were seen hunting within Parc La Visite. However, peasants indicate that there are many feral cats in the area. It is common to find cat feces along the trails of the park. I examined the contents of all feces collected in Parc La Visite, and the results of these analysis indicate that cats are feeding primarily on rats, with some birds, mice and lizards being consumed.

H. The domestic dog, Canis familiaris, is common within the boundaries of Parc La Visite. Most dogs appear to stay near houses and to be associated with human activities. No packs of dogs were observed during the survey period. Examination of dog feces collected within the park indicates that dogs do eat Plagiodontia. Remains of P. aedium were found in two collections of feces from areas a kilometer apart. One dog was observed late at night hunting along the north face of the massif near Tete Opaque at 2200 meters elevation. One knowledgeable peasant from

near Tete Opaque (Lucien Derville) observed dogs killing "Zagouties", as well as digging Black-capped Petrels from their burrows and eating them. It is likely that dogs have a negative impact on other endemic birds and mammals as well. Dogs kill many S. paradoxus in the Dominican Republic (Jose Ottenwalder, personal communication) and I have a documented case of a dog killing a S. paradoxus near Duchity in the Departement de la Grande Anse. The large number of dogs in the Parc National La Visite region appear to have eliminated S. paradoxus from the area. Whenever possible, therefore, dogs should be removed from the park, and peasants living in or near the park should be prohibited from keeping dogs.

#### Summary (Tables 1, 2, 3, 8, 9)

The terrestrial mammals found within the park include, in order of abundance: 1) the Black rat (Rattus rattus); 2) the House mouse (Mus musculus); 3) the mongoose (Herpestes auropunctatus); 4) the "Zagouti" (Plagiodontia aedium). The cat and to some extent the dog are also functioning as "wild" mammals because they are living in a feral state. The habitats within Parc National La Visite are highly disturbed in terms of the mammalian fauna. Based on trapping data collected during the course of the survey I estimate that 75 percent of the species and 98 percent of

individual terrestrial mammals present in the park are introduced non-endemics associated with habitat alteration and the effects of human activities. The altered state of the park is also indicated by an examination of the habitats where mammals are most abundant. The average trapping success within the park for small mammals is 9 percent (see Table 2). The trapping success for the undisturbed broad-leaved forest (Rak Bwa) was 13 percent, slightly above the average for the park and very similar to average trapping success in natural habitats in eastern North America (10 percent). The trapping success in the mature pine forest is 5 percent, which is less than half that for the mesic broad-leaved forest but consistent with data from natural pine habitats elsewhere. However, success in the disturbed broad-leaved forest (Bwa Raje) was 30 percent and in the open disturbed areas (Raje) it was 26 percent, indicating that introduced species in disturbed habitats form the dominant component of the mammal fauna of Parc National La Visite.

It is clear from these data that all possible measures should be taken to protect the mesic broad-leaved forest of the region and to promote conservation activities that will encourage the preservation of Plagiodontia aedium. Some measure of controlled forestry in the region around the park is compatible with this goal. However, agriculture and human habitation within or near the boundaries of the park

are not compatible with the continued survival of the remaining endemic land mammals of the area.

#### D. Extinct Land Mammals of Parc National La Visite

The land mammals known to have existed in the area of the Parc National La Visite based on an analysis of remains collected in sinkholes and caves are listed in Tables 3, 8. All of these except the "Zagouti", (Plagiodontia aedium) have become extinct. Some of these extinctions occurred within historical times (after the arrival of Columbus in 1492 and sometime after the observations of Oviedo who discussed the natural history of the island in about 1540). Some biologists considered it possible that two species might continue to exist in remote areas of the Massif de la Selle (Miller, 1930; Woods et al., 1986). These mammals are the Hispaniolan Spiny Rat (Brotomys voratus) and the Hispaniolan Island Shrew (Nesophontes paramicrus). Careful analysis of a variety of habitats in the La Visite area over the last three years, however, indicates that it is unlikely that any endemic land mammals other than Plagiodontia aedium continue to exist in the Morne La Visite region (Woods et al, 1986). The reasons for the loss of the endemic land mammals ranked in order of importance are: 1) habitat destruction; 2) introduction of commensal predators (dogs, cats and the mongoose); 3) introduction of commensal

competitors (rats and mice); 4) hunting by indians and peasants. Hunting surely had the greatest impact on the larger endemics, such as the ground sloth, the primate and the large zagouti Plagiodontia velozi. Indians are also known to have kept large numbers of the smaller zagouti-like rodent Isolobodon portoricensis in captivity, and the remains of this rodent and the spiny rat, Brotomys voratus, are common in indian kitchen middens.

E. Bats of Parc National La Visite (Tables 5, 7)

Parc National La Visite is above 1600 meters elevation (5280 feet). The climate is cool and few fruit bearing trees grow in most areas of the park except in the broad-leaved forest on the north side of the La Selle Escarpment and in ravines, around sinkholes and on karst domes. The number of potential species of bats that might occur in the region therefore is limited to insectivorous forms and bats with mixed food habits, and is far less than the 18 species and subspecies of bats known to exist in Hispaniola. Table 4 lists the name and distribution of all species of bats known to exist in Haiti at the present time. An examination of fossil and sub-recent material from several caves within the boundaries of the park indicate that eight bat taxa occurred in a sample that accumulated within the past 10,000 years (and probably largely accumulated in the last 2000 years since most remains were on the surface of the cave deposit). The eight taxa are listed in Table 5 and represent my best estimation as to the natural composition of the bat fauna of the Parc National La Visite region before it was altered by man.

The bats collected or observed within the boundaries of Parc National La Visite during the period of



investigation are listed below with comments about the biology of each species.

Eptesicus fuscus hispaniolae - Big Brown Bat

Observed in a cave at 2100 meters elevation south of Pic La Visite, and over the Riviere Blanche at several locations.

This bat feeds on insects, and possibly changes elevations depending upon the season. The bats were not present in a cave near the ridge of Morne La Visite in January/February 1983, 1984 or 1985, but were observed in that cave in March 1982, and many were flying over the Riviere Blanche on 27 May 1982 during the first hour after dark.

Number of individuals: 12

Date: March 1982, May 1982

Monophyllus redmani clinedaphus -Leach's Long-tongued  
Bat

Captured in a mist-net at 2100 meters elevation set across a small stream with thick riparian scrub cover. The stream flows downhill into a large cave and is surrounded by open habitat.

This small bat has the ability to feed on nectar of flowers as well as fruits and insects. It is well suited to survive at higher elevations where fruit and insects are limited in number.

Number of individuals: 3

Date: 26 May 1982, 14 January 1985

Phyllops haitiensis - Dominican Fig-eating Bat

Captured in a mist-net set at 2150 meters elevation set in a Rage area near the ridge of the Massif de La Selle 1 kilometer E. of Morne La Visite.

This bat feeds on fairly hard fruit, and has well developed dentition and strong jaw muscles. The bat has a white patch on its shoulder and a nearly clear section in the membrane of its wing.

Number of individuals: 1 female

Date: 14 January 1985

Tadarida brasiliensis constanzae - Haitian Free-tailed  
Bat

Captured in a mist-net set across the upper Riviere Blanche near the waterfall at 1900 meters elevation.

This species of fast flying bat hunts over a wide area and feeds on insects. It does not appear to be present in the park during winter months.

Number of individuals: 3

Date: 27 May 1982

Discussion of La Visite bat fauna (Tables 5, 8)

The four species of bats recorded from the La Visite region in various periods between 1982 and 1985 represent a sample that is only 50% of the bat fauna known to exist in the La Visite region during the past 10,000 years. Most of the sample is from the surface of a sinkhole, Trouing Jean Paul, and is less than 10,000 years old. The eight species recorded from the surface of Trouing Jean Paul include all of the species known to still occur in the La Visite region. Four taxa are all or mostly insectivorous (50%), two taxa are mostly frugivorous (25%) and two taxa have mixed food habits that include insects, fruits, pollen and nectar (25%). Of the four taxa that are still present in Parc La Visite, two are insectivorous (50%), one is a mixed feeder (25%) and one is a fruit feeder (25%). The proportions of taxa in each feeding niche remains the same for the present day bat fauna of four species as it was for the larger group of eight species found in the last several thousand years. Of the four missing bat taxa, all are difficult to net and are normally less abundant than are the species encountered during the course of the survey. A more intensive collecting effort over a longer period might produce all eight taxa.

As a general statement, the bat fauna of Parc National La Visite does not appear to be very different in composition from the known bat fauna that existed before the

habitat was altered by forest destruction and habitat alteration. The data collected during the course of the survey suggest that the bat fauna within the park changes seasonally and that more species are present between March and November (the warm and wet period) than between December and February (the cool and dry period). The current known bat fauna of Parc La Visite is half the total known bat fauna for the region, however, and less than half the current known bat fauna of Parc National Pic Macaya. I believe that this is the result of extreme habitat degradation within the boundaries of the park. An important first step to restoring the species diversity of bats to the park would be to include Morne d'Enfer into the boundaries of Parc National La Visite. This addition would add significant areas of mesic broad-leaved forest habitat to the protected zone of the park and increase the percentage of suitable feeding areas for bats.

Mammalian Fauna  
of  
Parc National Pic Macaya

A. Introduction

The survey of the mammals of Parc National Pic Macaya sampled most regions of the park between the karst hills on the Plain of Formon at 950 meters elevation and the pine forests of the top of Pic Macaya at 2347 meters elevation (Map 3). Parc National Pic Macaya differs from Parc National La Visite in having more habitat diversity because of the dramatic elevational gradients associated with the peaks of Formon and Macaya and the deep ravines of the Riviere Ravine du Sud, R. de Port-a-Piment, R. L'Acule, R. des Roseaux and R. de la Guinadee (sometimes called the R. Tardieu). The main areas sampled for mammals were: 1) the broad-leaved forest in the area of exposed karst topography on the Plain of Formon at 1000 meters elevation; 2) the mixed broad-leaved and pine forests at 1650 meters elevation on the north slope of the Ridge of Formon; 3) the extensive broad-leaved forest on the north ridge of Pic Formon (2219 meters elevation); 4) the mature pine forests (with a dense understory of broad-leaved vegetation in depressions) on the top of Pic Macaya; 5) the diverse habitats located along the valley of the Riviere Ravine du Sud between 1050

and 1650 meters elevation. The natural forest cover on the Plain of Formon has been altered since Eric Ekman visited Formon in 1917 and 1924, and reported dense forest down to a level of 1000 meters elevation (Ekman, 1926). The forest is now cut throughout the Plain of Formon except for patches of broad-leaved forest that cover exposed areas of karst topography in the karst hills at the southern edge of the Plain of Formon. These regions are known locally as "Bwa Formon" and "Bwa Deron". The steep mountain slopes north of the Plain of Formon are now deforested to an elevation of 1500 meters, and patches of forest have been cut on both Pic Formon and Pic Macaya up to an elevation of 2000 meters. The forest cover in the Grande Ravine du Sud is extremely altered by cutting, burning, overgrazing and agriculture. The largest remaining areas of natural habitat are the wet broad-leaved forests of Pic Formon and the mixed broad-leaved and pine forests of Pic Macaya. Both forests stretch along the ridges of two separate ranges which parallel each other in an east-west direction.

#### B. Habitats surveyed

1. Bwa Formon is on the upper Plain of Formon at 1100 meters elevation SSE of Pic Formon ("Rak Bwa Woch").

2. Kay Ogile at the ridge of the Formon mountains is

at 1680 meters elevation and 2 km SE of Pic Formon. The habitat includes the pine and scrub forests in the adjacent ravine down to 1540 meters elevation ("Bwa Raje").

3. Pic Le Ciel is located adjacent to a meadow on the east ridge of Formon between 2100 and 2170 meters elevation .6 km SE of Pic Formon ("Rak Bwa Le Ciel").

4. Pic Formon is located on the east ridge of the Formon mountains west of Pic Le Ciel (2170 meters). The elevation of Pic Formon is 2219 meters. The habitat extends northward down the ridge to 2095 meters elevation ("Rak Bwa Formon").

5. The south shoulder of Pic Macaya at 2200 meters elevation on an isolated pine forest covered ridge .5 km south of the highest point of (2347 meters) of the mountain ("Bwapen Raje").

6. The pine forest along the ridge of Pic Macaya above 2330 meters elevation ("Bwapen").

7. De Glace in the Ravine du Sud is 2 km SE of Pic Macaya beside the Riviere Ravine du Sud at 1040 meters elevation ("Bwa Raje").

### C. Recent Land Mammals of Parc National Pic Macaya

The data on the terrestrial mammals of Pic Macaya are summarized in Tables 6, 9 and 10. The results indicate that for each habitat more individuals were present in the Pic Macaya area than in the area of Morne La Visite. During the period of investigation 59% more mammals were encountered during the Macaya survey, and the average trapping success at Parc National Macaya was 14% as opposed to 9% for Parc National La Visite. Specific observations on the status of each species are listed below.

A. The mongoose (Herpestes auropunctatus) is known to occur at the base of Pic Formon on the Plain of Formon near "Portal Formon" at 1000 meters elevation where I observed one in 1983. During eight weeks of work in the area between "Portal Formon" and Pic Macaya over a three year period no additional mongoose were seen. Two mongoose were trapped in Tomahawk live traps near disturbed areas in February of 1985. One was trapped in the successional pine forest on the south shoulder of Pic Macaya at 2200 meters elevation. The area is surrounded by deforested and ruinate (Raje) habitat that extends into the lowlands. The second mongoose was trapped in the bottom of the Grande Ravine du Sud at 1040 meters elevation in a disturbed habitat surrounded by Bwa Raje forest. The area is near a main trail and several agricultural areas. Scat (feces) of a mongoose were



collected in the pine forest on the top of Pic Macaya at 2330 elevation in 1984. The area where the mongoose scat was collected is near a ridge of the mountain that was deforested by a forest fire in 1982.

B. The House mouse (Mus musculus) is only found in highly disturbed areas in Parc Macaya. It was collected in the basin below the eastern Ridge of Formon at "Kay Ogile" (Bwa Raje conditions) where the forest has been cut, gardens planted and a house built. This basin has been badly exploited during the past three years, with much additional forest destruction in the past year. As of February 1985 the forest was cut at the southeastern margin of the basin resulting in continual ruinate (Raje) conditions from the ravine of the Riviere de L'Acul upward into the basin below Kay Ogile. The house is a permanent structure with a metal roof and is located in the bottom of the basin. The presence of House mice in this otherwise mesic basin just below the virgin forest on the ridge of the Formon range appears to be associated with the recent modifications of the habitat. House mice were also collected in the upper area of the Riviere Ravine du Sud at 1900 meters directly below the highest peak on Macaya. The area is deforested. Numerous garden houses (ajupas) are located in the ravine and wandering flocks of goats and sheep graze on the nearby mountain sides. The mice were trapped near ajupas and on overgrazed hillsides.

C. The Norway rat (Rattus norvegicus) is abundant in several habitats within Parc National Pic Macaya. This rat is brown and white in coloration, and lives close to the ground. The Black rat, Rattus rattus, on the other hand climbs trees and lives in rocky areas, open ruinate habitats and in the thatch of ajupas and kays. Norway rats inhabit wetter habitats than Black rats. Where the two species have been studied, the Norway rat is more aggressive and usually replaces the Black rat. Within the Parc National Pic Macaya, Norway rats occur in: 1) the wet broad-leaved and pine forests on Pic Formon above 2100 meters elevation; 2) on the south shoulder of Pic Macaya in the successional pine forest; 3) on the top of Pic Macaya in the pine forest and; 4) in mesic habitats in the Grande Ravine du Sud at 1040 meters elevation in disturbed areas of broad-leaved and pine forest. The common ecological conditions associated with the areas where Norway rats were captured during the inventory period are: 1) a deep (15 - 100 cm) layer of pine needles, leaves and logs; 2) pine forest or a mixed forest of pines and broad-leaved vegetation; and 3) abundant rainfall (in excess of 3000 mm per year). Black rats can also exist in these same habitats. On Pic Macaya a Black rat was captured in the same trap that caught a Norway rat the previous night.

The Norway rat constructs subsurface runways in the deep litter of the forest floor. This species would be a

major competitor for any endemic species of mammal that also burrowed in the deep leaf layer. I believe that the three species of insectivores of the genus Nesophontes that were once found in the area were burrowing forms. It is not known how long ago these species may have become extinct, but it is possible that their extinction in the Macaya area is related to the presence of Norway rats in the Macaya mountains.

D. Rattus rattus, the Black rat, is abundant in all regions of the park sampled during the inventory period. It is the only species of rat found in the open ruinate (Raje) areas and in the drier broad-leaved forests along the margin of the Plain of Formon. Black rats are present on the top of Pic Formon and Pic Macaya. They may have gained access to these areas by following trails and ruinate areas caused by clearing the land for agricultural purposes and natural fires. As with the Norway rat, this species now lives deep in the forest in what appear to be "natural" areas and is living as a "wild" mammal in a natural state.

The Black rat is a potential competitor of Plagiodontia aedium in the drier broad-leaved forests where the two occur together. When the forest is cut, Black rats move into the rock crevices previously occupied by P. aedium. It is not clear whether black rats displace P. aedium, since both can occur together in the same habitat (for example Bwa Formon). This may be a transitional state, with rats slowly

replacing Plagiodontia, or it may be a dynamic equilibrium. Only a long term study can resolve this important question.

The Black rats living in low areas of the park are heavily parasitized by mites, which cover their ears, snouts and inguinal regions. The parasite load of rats living on Pic Formon and Pic Macaya is much lower than it is for rats collected on the Plain of Formon. Black rats in the lower broad-leaved forests have a red-brown coloration in patches on their chest, front legs and the inguinal region. It is not known if this is a color pattern of the local population, or caused by feeding on a specific nut or fruit. The location and extent of the patches of color vary, but are always the same color.

As with Parc National La Visite, Black rats occur in four color morphs in Parc National Pic Macaya. In most areas of the park brown color morphs dominate in pine areas and grey-black morphs dominate in open drier areas (Table 1). The relationship holds for areas of pure pine or dry broad-leaved forest. In the pine forest habitat on the top of Pic Macaya more dark morphs than brown morphs occur which seems to be in contrast with the pattern observed in other parts of the park and in La Visite. However, the pine forest of Macaya is unique in that almost all of the pines are mature forest giants with the understory being a wet broad-leaved forest. The forest conditions on the top of Pic Macaya, therefore, are a mix of

pine and broad-leaved habitats, and both color morphs of Rattus rattus occur in this area (Table 1).

E. The "Zagouti", Plagiodontia aedium, is common in the broad-leaved forest along the margins of the Plain of Formon. This forest grows on top of large limestone blocks with little exposed soil, and so the habitat has not been exploited for agricultural purposes. The presence of P. aedium is confirmed by signs such as 1) chewed twigs, branches and the trunks of small trees; 2) fecal pellets on rocks and along fallen logs; 3) white streaks on rocks where P. aedium scent-marks. The status of Plagiodontia aedium in the Bwa Formon area has been monitored over the past 3 years, and the numbers of individuals appear to be stable. However, as of February 1985 peasants have begun to cut and burn the forest on the limestone domes of "Bwa Formon" where P. aedium are found. The destruction of habitat usually leads to the elimination of the Plagiodontia living in an area because it: 1) removes the vegetation used as a food source; 2) allows dogs and cats to enter the area and kill Plagiodontia; 3) allows rats to increase in numbers with possible adverse effects on Plagiodontia.

As long as the forest cover on the limestone domes remains uncut, Plagiodontia aedium appear to be able to survive because they are able to find food, a moderate local climate and protection from dogs and cats. Zagouties live in crevices in rocks, climb about in trees and walk along

fallen logs as they feed. In this suitable habitat the animal can survive very close to human habitation and intense land use. It was not unusual for me to hear dogs barking, people talking and the sounds of chickens and goats in the distance as I worked in a limestone dome where there were frequent signs of Plagiodontia. The animal appears to be able to survive in the midst of moderate land use and human presence if suitable habitats are large enough and protected from exploitation. The huge blocks of limestone in the karst hills offer protection to the animals and limit the adverse effects of humans, dogs and cats. In areas where the blocks of limestone are not exposed the animal is more vulnerable to predation and detection and less able to survive in close proximity to humans. In these areas dogs and cats must be removed, and the animal protected from hunting.

No Plagiodontia aedium were found in any of the habitats on Formon and Macaya where the forest cover is either virgin (as in areas on Pic Formon, Pic Macaya and Pic Macaya south) or disturbed (as around Pic Le Ciel, Kay Ogile and De Glace in the Ravine du Sud). This finding was a surprise to me, since in all of these areas large regions of nearly undisturbed forest exist. The missing factor in all of these habitats, however, appears to be the lack of extensive exposures of fragmented limestone (karst). .I

conclude that karst topography in conjunction with forest cover is necessary for Plagiodontia to survive.

Dogs, cats, mongoose and rats are common in the Macaya area, as they are throughout Haiti and represent a significant hazard to Plagiodontia. Heavy predation by these forms may result in the extirpation of Plagiodontia when crevices for the animal to seek shelter in are lacking.

The distribution of Plagiodontia in the Bwa Formon area of the Plain of Formon at the southern base of the Ridge of Formon indicates that this area should be included in the park. Observations on captive Plagiodontia from southern Haiti in comparison with captive individuals from the northeastern Dominican Republic suggest that the Haitian population (sometimes classified as a separate species and other times listed as a distinct subspecies) has several important behavioral differences that characterize the Haitian animals. For example, the Haitian population of Plagiodontia is more terrestrial in habits and better able to live in close proximity to disturbance. For this reason, it is appropriate to consider the animals living in both national parks in Haiti as the "Haitian Hutia" or "Zagouti" as opposed to the animals that live north of the Cul-de-Sac between Port-au-Prince and Barahona (Dominican Republic). There are no known populations of Plagiodontia aedium in Haiti that survive north of the Cul-de-Sac (i.e. in northern Haiti). This gives added significance to the populations of

Plagiodontia that occur in the Bwa Formon region of Parc National Pic Macaya as well as in Parc National La Visite.

F. Solenodon paradoxus, or the Haitian Solenodon ("Nez Longe") is known to occur in the Parc National Pic Macaya area. The evidence that confirms the presence of Solenodon in the Parc Macaya region is the presence of numerous bones in sinkholes on the Plain of Formon and two feces collected at 1900 meters in the dense forest on the Ridge of Formon above Kay Ogile on the trail between Portal Formon and De Glace. Bones of four Solenodon were collected in peasant gardens during a separate two year survey of the nearby Duchity area. These animals were either killed by peasants with rocks or were killed by dogs. The area of the survey was less than 5 km northeast of Pic Macaya in the plateau between Pic Macaya and Duchity (just outside the boundaries of the park).

I am confident that no Solenodon are found within the current boundaries of Parc National Pic Macaya. Solenodon is not nearly as capable of escaping into rock crevices as Plagiodontia, and therefore is even more vulnerable to being killed by dogs and cats. The effect of mongoose on Solenodon is unknown. Solenodon is totally nocturnal, whereas the mongoose is mostly diurnal. It is clear, however, that if Solenodon is going to continue to survive in Haiti, and especially in the Parc National Pic Macaya region, that the numbers of dogs and cats will have to be



controlled in the park. It is also important to protect areas of flat land where the Solenodon can hunt for its natural foods (snails, beetles and millipeds). For this reason I recommend protecting the "basin" east of Kay Ogile, and the upper Plain of Formon (often called the Plain of Deron) west of Portal Formon. If Solenodon is to be protected and included in the park then the area called "Mare Cochon" east of the current boundaries of the park must be added to the park and the Plain of Deron must be "managed" by removing dogs and cats and undergo extensive reforestation efforts.

G. No cats were seen hunting during fieldwork over a three year period. However, cat feces were seen on trails throughout the park, including the pine forest on top of Pic Macaya. I assume, therefore, that feral cats are widespread in the park.

H. Dogs are abundant on the Plain of Formon near Portal Formon. They range along the plain and hunt at night. No dog feces were seen with remains of Plagiodontia in them during the course of the study. Dogs were not seen on Pic Formon or Pic Macaya, but were encountered at De Glace in the upper Grande Ravine du Sud.

D. Extinct Land Mammals of Parc National Pic Macaya (Table 8)

The land mammals known to have existed in the area of Parc National Pic Macaya are listed in Table 6. The list is based on remains collected in three deep sinkholes on the Plain of Deron, and from one sinkhole on the ridge of Pic Macaya. These sinkholes, some of which are 100 meters deep, have served as "pit traps". The animals whose remains are found in the bottom of the sinkholes can be presumed to have fallen in, and therefore to have lived in the immediate vicinity of the sinkhole. The relative percentages of the various taxa reported in Table 6 is assumed to represent a reasonable approximation of the abundance of the various forms.

All endemic forms present on the Plain of Deron and in the Macaya Mountains are now extinct with the exceptions of Plagiodontia aedium and Solenodon paradoxus. There are no  $C^{14}$  dates of the material from Parc National Pic Macaya, but  $C^{14}$  dates from a similar fossil site just east of the Plain of Formon indicate that most of the taxa, including the primate, were present as recently as 3000 years ago. Such forms as Brotomys voratus, (a small rat-like rodent), Isolobodon portoricensis (an animal similar to the "Zagouti" but probably diurnal), Plagiodontia velozii (a form of Zagouti that was three times as large as Plagiodontia aedium) and the three species of the genus Nesophontes (a small shrew-like insectivore) became extinct even more recently since their bones are found on the surface of the

cave and sinkhole deposits and are mixed with the bones of rats and mice. The data indicate that it is likely that they became extinct in the Formon/Macaya region as recently as this century, and that their extinctions may relate in part to habitat destruction and the effects of dogs, cats, rats and the mongoose. The insectivore Solenodon marcanoi, which is similar in morphology to the surviving "Nez Longe" except that the animal had much shorter limbs and was somewhat smaller in body size, was also present in Parc Macaya. No recent signs of this animal were found during the course of the inventory.

It is possible that Solenodon marcanoi still survives in the area near Parc National Pic Macaya based on several reports by peasants of a dark colored "Nez Longe". A careful search for Brotomys and Nesophontes through all areas of the Macaya Mountains, however, indicates that these forms are extinct. The reasons for these extinctions might relate in part to the presence of rats. Rattus norvegicus, which burrows and makes use of the deep leaf litter in remote regions of the park, is the form with the greatest possible negative impact on Nesophontes. Fossil evidence from an analysis of cave and sinkhole deposits indicates that these areas served as refugial preserves for many endemic mammals during previous climate cycles of the Pleistocene when Haiti became extremely dry and cold at regular intervals. The data from an analysis of sinkhole

deposits also indicate that the area of Parc Macaya may have served as one of the last refuges for some endemic terrestrial mammals well into this century.

E. Bats of Parc National Pic Macaya (Table 7)

The habitats of Parc National Pic Macaya are more diverse than those of Parc National La Visite because the park includes lowland regions on the Plain of Formon (1000 meters elevation) as well as montane regions receiving over two times as much precipitation as La Visite. The diversity of the bat fauna would be expected to be much greater in the Formon/Macaya region than in the La Visite region as a result. The numerous sinkhole deposits on the Plain of Deron are usually damp and therefore delicate bat bones are poorly preserved. No extensive cave deposits are known from within or near the park. Therefore, no extensive assemblage of fossil bats exists that is comparable to the list presented for La Visite (Table 4).

The bats collected or observed within the boundaries of Parc National Pic Macaya (Table 7) during the period of investigation are listed below with comments about the biology of each species.

Eptesicus fuscus hispaniolae - Big Brown bat

Four males were collected in a mist net set across a saddle between two ridges on the north slope of Pic Macaya at 1250 meters elevation. One male was collected in a mist net set across the Riviere Ravine du Sud at 1040 meters elevation. The latter was one of approximately 50 individuals that were flying over the riverbed at dusk.

Number of individuals collected: 5 males

Dates: 27 May 1975, 28 January 1985

Artibeus jamaicensis jamaicensis - Jamaican Fruit-eating Bat

Collected in a mist net near a limestone dome on the Plain of Formon at 975 meters elevation.

Number of individuals collected: 1 male, 2 females

Date: 24 January 1984

Phyllops haitiensis - Dominican Fig-eating Bat

Collected in a mist net near a limestone dome on the Plain of Formon at 975 meters elevation. The surrounding area is open with numerous gardens and fruit trees.

Number of individuals collected: 2 males

Date: 21 January 1984; 24 January 1985

Monophyllus redmani clinedaphus - Leach's Long-tongued Bat

Four females were collected in a mist net near a limestone dome on the Plain of Formon at 975 meters elevation. Two females were collected in a mist net beside

a clearing in a broadleaf forest on Pic Formon at 2170 meters elevation. Seven females were collected in a mist net in a saddle below Pic Formon at 2170 meters elevation. Seven females were collected in a mist net on the top of Pic Macaya in a pine forest at 2300 meters elevation. Three females were collected in a mist net at Kay Ogile on the southern slope of the Formon mountains at 1650 meters elevation.

Number of individuals collected: 23 females

Dates: 2 February 1984 and 22, 24, 25, 26, 28,  
31 January and 1 February 1985

Phyllonycteris poeyi obtusa - Haitian Flower Bat

One male was collected in a mist net at Kay Ogile on the south side of the Formon Mountains at 1650 meters.

Number of individuals collected: 1 male

Date: 1 February 1985

Erophylla sezekorni bombifrons - Hispaniolan Brown  
Flower Bat

Collected in a mist net near a limestone dome at 975 meters elevation on the Plain of Formon.

Number of individuals collected: 2 males

Date: 22 January 1985

Pteronotus quadridens fuliginosus - Sooty Moustached  
Bat

Collected in a mist net set in a saddle at 1250 meters elevation on the north slope of Pic Macaya.

Number of individuals collected: 1 female  
(pregnant with  
single embryo)

Date: 27 May 1975

Pteronotus parnellii pusillus-Parnell's Moustached Bat

Collected in a mist net set in a saddle at 1250  
meters elevation on the north slope of Pic Macaya.

Number of individuals collected: 1 female

Date: 27 May 1985

Tadarida brasiliensis constanzae - Haitian Free-tailed  
Bat

Collected in a mist net in a saddle at 1250 meters  
elevation on the north slope of Pic Macaya.

Number of individuals collected: 1 female  
(pregnant)

Dates: 27 May 1985

### Discussion of Pic Macaya bat fauna

The nine species of bats recorded from the Formon-Macaya region represent more than twice the number of taxa collected in the La Visite region during the survey period (Table 7). The total number of bat taxa from Formon-Macaya is similar numbers to the known bat fauna from La Visite if data from recent and cave deposits are combined for La Visite (8 taxa from La Visite; 9 taxa from Formon-Macaya). However, the mix of species differs between La Visite and Formon-Macaya. Erophylla (frugivorous), Artibeus (frugivorous), and two species of the genus Pteronotus (insectivorous) are found in the Formon-Macaya area, but are not reported from La Visite, whereas Brachyphylla (mostly insectivorous but occasionally frugivorous) and Lasiurus (insectivorous) are only reported from La Visite. The food habits of the bats of Formon-Macaya are: insectivorous (44%); mixed insect, fruit, nectar and pollen feeders (11%); frugivorous (22%); mostly fruigivorous but some flower parts (22%).

A comparison of the general feeding categories of the bat fauna of La Visite and Formon-Macaya indicates that there are more insect feeders in the La Visite park (75%), whereas in the Formon-Macaya park insect feeders are less abundant (55%). In neither park, however, are frugivorous species as abundant as insectivorous taxa.



A comparison of the collecting data from the two parks (Table 7) indicates that bats are more numerous in Parc National Pic Macaya than in Parc National La Visite. Only 33 percent of the total taxa and 15 percent of the total number of individual bats collected in the study came from the area of Parc National La Visite. Part of this is a reflection of the geography of the parks, since Parc National La Visite is largely composed of a high plateau that is moderately homogeneous in topography. Parc National Pic Macaya is much more diverse in topography, and ranges in elevation from 975 meters to 2347 meters. However, more than topography alone is associated with the paucity of bats at La Visite when compared with Formon-Macaya.

Within the boundaries of Parc National La Visite are numerous caves, sinkholes and ravines. These habitats form excellent roosts for bats, and I would expect bats to be more abundant and diverse than the four species recorded. An important limiting factor for bats in La Visite may be the extensive habitat destruction, especially of the hardwood forest that surrounds the pine stands and should occur in depressions and along ravines. These hardwood stands (Rak Bwas) have been reduced to small remnants of ruinate habitat (Bwa Rajes). The loss of these habitats is most severe within Parc National La Visite, and may be a contributing factor in the reduction in bat species from the 8 taxa in the fossil record to the 4 species now occurring

in the park. The composition of the broad-leaved forest is described in detail by Judd (1986) in this report, and by Holdridge (1947) in his dissertation on the pine forests of Haiti.

### Discussion

After investigating the recent and extinct mammals of both national parks in Haiti several facts become clear. The first is that each park had a remarkable assemblage of endemic terrestrial mammals as recently as 3715 year ago (MacPhee and Woods, 1982) and probably much more recently (Woods et al, 1986). These animals are listed in Tables 2, 3, 6 and 8. The pattern of extinction of these species is not unique to Haiti. Across the Antilles there were at least 134 species of native mammals present in the past 10,000 years. The extinction rates for these species has been very high. While most species of bats continue to survive, 88% of the terrestrial mammals have become extinct (Woods et al., 1986; Morgan and Woods, 1986). A list of all the known endemic land mammals of the national parks of Haiti is presented in Table 8. Of the 23 species of endemic land mammals known to occur in Hispaniola all but two have probably become extinct (see below) for an extinction rate of 86 percent, which is slightly better than the pan-Antillean average. The exact reasons for these

extinctions are unclear but probably relate to many of the factors discussed in this report.

1. Predation on smaller forms by introduced carnivores (dogs, cats and mongoose) that are now living as wild animals in a natural state in almost all sections of Haiti and are very abundant in the national parks.

2. Competition for limited resources among the smallest forms with Rattus rattus, R. norvegicus and Mus musculus. These three introduced rodents are now abundant in most terrestrial habitats in Haiti. Rattus norvegicus is common in lowland wet areas and is the dominant form in rice fields as well as occurring in the deep pine litter of virgin pine forests of the highest mountains. This burrowing form would have been in direct competition with semi-fossorial endemic species that might have occurred as a last refuge in the deep litter of the virgin pine forests. I believe this was the last habitat of Nesophontes and Brotomys. Rattus rattus occurs in drier areas and in open forests without a deep leaf litter layer. These rats climb readily and would have excluded semi-arboreal species of endemic mammals.

3. Habitat destruction and the fragmentation of habitats into units too small to maintain species diversity. This unfortunate phenomenon began soon after the arrival of Columbus and has accelerated in recent decades. Cohen

(1984) has documented that within the boundaries of Parc National Pic Macaya 96.4% of the virgin forest has been destroyed since 1956 when the area was 100% covered with "essentially virgin forest". Cohen estimated that only 38.2% of the total area of Parc National Pic Macaya had any forest cover at all in 1984.

These three factors have acted together in the past to eliminate most of the endemic land mammals of Haiti and continue to influence the status of the remaining populations of Plagiodontia aedium and Solenodon paradoxus. The number of P. aedium estimated to be present in each park in 1985 was considerably reduced from the numbers estimated to be present in 1980. In La Visite the large population present in 1980 was reduced to one confirmed individual in 1985 by: 1) nearly complete deforestation of the existing broad-leaved forest by peasants in order to make gardens; 2) predation by dogs (two confirmed cases where a dog ate a Plagiodontia); 3) hunting by peasants (one confirmed case where a peasant killed a Plagiodontia with a machette); 4) competition or harrassment by Rattus rattus (which between 1980 and 1985 became abundant in the habitat previously occupied by Plagiodontia). Rats now can be trapped in crevices where Plagiodontia occured a year or more before.

Within both parks the introduced mammals have expanded their ranges into most habitats including the few remaining

regions of completely natural forest. The natural mammal community of both parks (Table 9) is now composed of rodents (Rattus rattus [four different color morphs], R. norvegicus and Mus musculus) living in the ground and lower vegetation and feeding on plant products and small animals. The mongoose serves as a general carnivore that feeds on insects, small reptiles and amphibians as well as small mammals and birds. The impact of the mongoose on ground nesting birds such as the Killdeer, Bobwhite Quail as well as the Black-capped Petrel is unknown, but based on the impact of the mongoose on similar species elsewhere in the world it can be inferred that the impact is probably negative. Dogs and cats live in a feral state in both parks and serve as top level carnivores. My analysis of fecal remains collected within the boundaries of the parks indicates that cats feed mostly on small birds, rats and mice. Dogs feed on a variety of things including birds and Plagiodontia. They are known to readily kill Solenodon and would be the major danger to this species wherever they occurred together. Add to this the impact of goats, sheep, cows, and in some areas even pigs and it is clear that little remains of the habitat to support endemics (Table 9).

### Conclusions

A recent in depth search of the land areas contained within each national park for remaining endemic species produced a discouraging conclusion. Over the past ten years I have reviewed all accounts of endemic mammals in the literature and interviewed many peasants to evaluate the stories of animals that might be one of the species listed in Table 8. I have concluded that several species in this list survived in the areas of both national parks into this century. These animals are Nesophontes paramicrus, N. hypomicrus, N. zamicrus, Brotomys voratus, Isolobodon portoricensis and Plagiodontia velozii (Woods, et. al. 1986). These mammals, three shrew-like forms, one spiny rat, one "Zagouti-like" form and one giant Zagouti were all present in 1930 (Miller, 1930). Stories of small shrew-like mammals persist in nearby areas of the Dominican Republic well into the 1960's (Clayton Ray - unpublished field notes; Donald Dod, personal communication) and I have received stories matching the probable appearances of Brotomys voratus and Plagiodontia velozii. Fecal pellets that did not match the shape of pellets from any unknown rodent were collected in Macaya in 1983, and in 1983 and 1984 a small rodent was seen by three members of the inventory team that reportedly looked like "a chipmunk" in the "Grande Ravine" of Parc National Pic Macaya. These accounts are encouraging signs that some additional endemic mammals may still survive in some sections of Hispaniola. However, the apparent high

density of rats, cats, dogs, and the mongoose as well as the extent and rate of deforestation and habitat destruction in both parks are all causes for great alarm. I suggest (Woods, et al, 1986) that all endemics other than Plagiodontia aedium and Solenodon paradoxus are now extirpated in both national parks, and that some of these extinctions have occurred in the last several decades. I believe that mongoose, dogs and cats have increased markedly in numbers within the parks in the last five years as a result of increased human disturbance.

The status of Solenodon paradoxus is very endangered. This large and unusual insectivore is most closely related to mammals that became extinct in North America 30 million years ago, and is therefore a "living fossil". My analysis of the fossil deposits in sinkholes in the interior of each national park indicates that Solenodon was once present in greater numbers in both of the parks. Today it is gone in all but two possible regions. One area is on the plain of Morne d'Enfer west of the current boundaries of Parc National La Visite. This area of wet broad-leaved forest (Rak Bwa) is relatively undisturbed and has numerous patches of exposed limestone as well as deep moist soils. This habitat must be protected from deforestation and the introduction of dogs, cats and mongooses which can be done by including Morne d'Enfer in Parc La Visite. The second

region in Haiti that is most suitable for Solenodon paradoxus is the broad plain that stretches north of the Ravine du Sud, east of Pic Macaya and west of the towns of Catiche and Duchity. Between 1981 and 1983 I conducted a survey of the mammals of this region with the centers of the survey being Duchity 13 kilometers northeast of Pic Macaya and Catiche 15 kilometers directly east of Macaya. Catiche is where I found the first confirmed specimens of Solenodon from Haiti (Woods, 1976). All animals found dead in gardens, killed by dogs or otherwise encountered by peasants were brought to Duchity where a record was kept as to the: 1) date; 2) location; 3) nature of the habitat in the region; and 4) reason for death of each animal. Of 38 animals accounted for during the survey 4 were Solenodon paradoxus. The largest number of S. paradoxus came from the region of "Mare Cochon" (3 individuals) which is an irregular plain with blocks of exposed karst and collapsed sinkholes at an elevation of approximately 1200 meters. All of the specimens came from an area west of the "Les Cayes to Jeremie" road, and therefore are in the "region" of Macaya. The area is one of the wettest in all of Hispaniola and receives more than 4000 mm of precipitation each year. The area has wet soils that are rich in invertebrates. Many rocks and karst blocks are exposed and few people, dogs and cats are found in this region. I believe that this is the single most important area in Haiti for Solenodon.



### Summary

The conclusions and recommendations that I would make, based on the fieldwork and analyses presented here, are listed below.

1. Introduced mammals now form the largest component of mammalian fauna of both parks, and are living in a "natural state" in the parks.

2. These introduced forms may have caused severe damage to the status of the endemic mammals of the parks and may have contributed to the extinctions of some endemics in the last few decades.

3. All introduced mammals, but especially the mongoose negatively impact the status of birds that nest on the ground, and may affect the breeding success in species that nest low in trees and in burrows and crevices such as the Black-capped Petrel.

4. Rattus norvegicus occur in areas with deep pine litter and abundant rainfall. These rats make extensive runways in the pine litter.

5. Rattus rattus occur in four color morphs. Dark morphs are found in dry areas, open forests and wet broad-leaved forests with a shallow leaf litter zone. Brown

morphs occur in pine forests. Black rats are frequently seen in the branches of trees at night.

6. The mongoose has recently arrived in the highest regions of the parks. I do not believe it was in these same habitats five years ago.

7. Plagiodontia aedium occur in both parks in areas where mesic broad-leaved forest grows on and around karst. This habitat provides food and shelter for the mammal. Plagiodontia can co-exist with dogs, cats and rats in this specific habitat. Plagiodontia has been eliminated from all other habitats, even when the forest is present and appropriate food plants are available, suggesting that without shelter Plagiodontia are easily killed by dogs and people.

8. Solenodon paradoxus is not present in either national park within the boundaries as now drawn. In order to protect Solenodon the parks must be expanded in size to include the plain of Morne d'Enfer west of Parc La Visite and Mare Cochon east of Parc Macaya.

9. Several endemic species on Table 8 may have survived into recent times. This is especially true of Parc Macaya where I suspect Nesophontes and Brotomys were present until the last few years. Based on a separate survey in

1985 I now consider these species to be extinct (Woods, et al., 1986).

#### Five Most Important Actions

1. Expanded Parc National La Visite westward to include all of Morne d'Enfer.
2. Expand Parc National Pic Macaya eastward to include the Mare Cochon area.
3. Initiate a policy of removing all dogs and cats in the parks.
4. Initiate a research program to determine the impact of rats and the mongoose on Plagiodontia aedium.
5. Create "Biological Reserve Zones" on 1) the north face of the La Selle Escarpment between Morne d'Enfer and Morne Kaveneau; 2) the entire Ravine of the Riviere Blanche; 3) the entire region of the karst hills on the Plain of Formon; 4) the entire Mare Cochon region east of Pic Macaya.

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and B) Phyllonycteris poeyi obtusa, a fruit,  
pollen, nectar and insect eating bat.

Table 1. Frequency of Rattus by habitat and color morph in the National Parks of Haiti.\*

	Open areas	Pine forest	Broad-leaved forest
Parc National La Visite			
<u>Rattus rattus</u>	9	10	10
Brown morph	5	9	3
Black morph	4	1	7
Plain of Formon			
<u>Rattus rattus</u>	-	-	14
Brown morph	-	-	1
Black morph	-	-	13
<u>Rattus norvegicus</u>	-	-	8
Macaya/Formon Mountains			
<u>Rattus rattus</u>	-	49	24
Brown morph	-	18	9
Black morph	-	31	15
<u>Rattus norvegicus</u>	-	10	-

\* Number of individuals in each habitat type based on the same trapping effort in each area.

Table 2. Summary of trapping data on land mammals collected within the boundaries of Parc National La Visite.

Location	Trap nights	Black rat	Norway rat	Mouse	Mongoose	% success
1.Rak Bwa	31	4	0	0	0	13%
2.Bwa Raje-1	24	0	0	0	0	0%
3.Bwa Raje-2	20	6	0	0	0	30%
4.Raje	58	10	0	4	1	26%
5.Pine Forest	283	10	0	4	0	5%
6.Riparian	102	8	0	0	0	8%
7.Succesional Pine	105	0	0	3	0	3%
Summary	623	38	0	12	1	9%

Table 3. List of fossil and recent land mammals collected in sinkholes and cave deposits within the Parc National La Visite (C=common; U=uncommon; R=rare; EX=extinct; LE=locally extinct).

	Current status	Status fossil record	Comments
<b>Order Rodentia</b>			
Family Capromyidae			
<u>Plagiodontia aedium</u>	R	U	always an uncommon and secretive form
<u>Plagiodontia veloz</u>	EX	U	present until colonial times; largest known zagouti; may survive in adjacent areas of Dom.Rep.
<u>Plagiodontia araeum</u>	EX	U	large heavy bodied form
<u>Isolobodon portoricensis</u>	EX	C	the most abundant of all endemic rodents until colonial times
<u>Isolobodon montanus</u>	EX	U	large heavy bodied form with similar characteristics to <u>Plagiodontia aedium</u>
<u>Hexolobodon phenax</u>	EX	U	long limbed, large bodied form
Family Echimyidae			
<u>Brotomys voratus</u>	EX	C	similar in size to a rat and very abundant until recent times
Family Muridae			
<u>Rattus rattus</u>	C	C (in post-Columbian deposits)	suddenly abundant in colonial times

Table 3. (continued)

	Current status	Status fossil record	Comments
<u>Mus musculus</u>	C	R (in post- Columbian deposits)	found only near disturbed areas
Order Primates			
Family Cebidae			
<u>Saimiri bernensis</u>	EX	R	found at several locations in park
Order Insectivora			
Family Solenodontidae			
<u>Solenodon paradoxus</u>	LE	C	extirpated in recent times
<u>Solenodon marcanoi</u>	EX	U	possibly survives in Dom. Rep.
Family Nesophontidae			
<u>Nesophontes zamicrus</u>	EX	C	extirpated within the last century
<u>Nesophontes hypomicrus</u>	EX	C	
<u>Nesophontes paramicrus</u>	EX	C	
Order Xenarthra			
Family Megalonychidae			
Several species	EX	C	extirpated within the last 1000 years

Table 4. List of the known recent bats of Hispaniola (6 Families; 15 genera; 18 species).

Family Noctilionidae

Noctilio leporinus mastivus - Greater Bulldog Bat  
Distributed throughout the Greater and Lesser Antilles,  
Mexico and Central America.

Family Mormoopidae

Pteronotus quadridens fuliginosus -Sooty Moustached  
Bat

Distributed in Jamaica, Puerto Rico and Hispaniola

Pteronotus parnellii pusillus - Parnell's  
Moustached Bat

Endemic to Hispaniola as subspecies

Pteronotus parnellii gonavensis - Parnell's  
Moustached Bat

Endemic to La Gonave Island, Haiti as subspecies

Mormoops blainvillii (=Aello cuvieri) - Antillean  
Ghost-face  
Bat

Distributed on Cuba, Jamaica, Puerto Rico and Hispaniola

Family Phyllostomidae

Macrotus waterhousei waterhousei - Waterhouse's  
Leaf-nosed Bat

Distributed in Southern Bahamas, Puerto Rico and Hispaniola

Monophyllus redmani clinedaphus - Leach's  
Long-tongued Bat

Distributed in Eastern Cuba, Southern Bahamas and Hispaniola

Artibeus jamaicensis jamaicensis - Jamaican Fruit-  
eating Bat

Distributed on Jamaica, Puerto Rico, Hispaniola and Lesser Antilles.

Phyllops haitiensis - Dominican Fig-eating Bat  
Endemic to Hispaniola

Brachyphylla nana - Antillean Fruit-eating Bat  
Distributed on Cuba and Hispaniola plus Caicos Islands

Phyllonycteris poeyi obtusa - Haitian Flower Bat  
Endemic to Hispaniola as subspecies

Erophylla sezekorni bombifrons - Hispaniolan Brown  
Flower Bat  
Hispaniola and Puerto Rico

#### Family Natalidae

Natalus stramineus major - Hispaniolan Funnel-  
eared Bat  
Endemic to Hispaniola as subspecies

Natalus micropus micropus - Small footed Funnel-  
eared Bat  
Distributed on Jamaica, Old Providence Island (Bahamas)  
and Hispaniola

#### Family Vespertilionidae

Eptesicus fuscus hispaniolae - Big Brown Bat  
Distributed on Jamaica and Hispaniola

Lasiurus borealis minor - Small Hairy-tailed Bat  
Distributed in Bahamas, Puerto Rico and Hispaniola

#### Family Molossidae

Tadarida brasiliensis constanzae - Haitian Free-  
tailed Bat  
Endemic to Hispaniola as subspecies

Tadarida macrotis - Big Free-tailed Bat  
Distributed in Southwestern United States, Mexico and  
the Greater Antilles

Molossus molossus verrilli - Hispaniolan Pallas  
Mastiff Bat  
Endemic to Hispaniola as subspecies

Table 5. Bats occurring in fossil deposits of Parc National La Visite representing strata deposited within the past 10,000 years.

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Order Chiroptera	<u>Major food source</u>
Family Phyllostomatidae	
<u>Monophyllus redmani</u>	Nectar and fruit.
<u>Phyllonycteris poeyi</u> <u>obtusa</u>	Fruit, pollen, nectar and insects.
<u>Erophylla sezekorni</u> <u>bombifrons</u>	Pollen, fruit, nectar and insects.
<u>Brachyphylla nana</u>	Pollen, insects, fruit, and nectar.
<u>Phyllops haitiensis</u>	Fruit.
Family Molossidae	
<u>Tadarida brasiliensis</u>	Insects.
Family Vespertilionidae	
<u>Eptesicus fuscus</u>	Insects.
<u>Lasiurus borealis</u>	Insects.

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Table 6. List of fossil and recent land mammals in order of abundance collected from a sinkhole at 1200 meters at the base of Pic Formon in the upper Plain of Formon (C= common; U+ uncommon; R= Rare; Ex= extinct).

	Current	STATUS		% of sample
		Fossil	Record	
<u>Plagiodontia aedium</u>	R	C		20.1%
<u>Rattus rattus</u>	C	C		13.9%
New genus and species of rodent	C	C		12.3%
<u>Nesophontes hypomicrus</u>	EX	C		11.5%
<u>N. paramicrus</u>				
<u>Plagiodontia velozii</u>	EX	C		9.0%
<u>Brotomys voratus</u>	EX	C		8.2%
<u>Hexolobodon phenax</u>	EX	C		7.4%
Ground sloths (several species)	EX	C		5.7%
<u>Isolobodon portoricensis</u>	EX	U		4.1%
<u>Solenodon paradoxus</u>	R	U		2.5%
<u>Solenodon marcanoi</u>	Unknown	R		1.6%
<u>Isolobodon montanus</u>	EX	R		1.6%
<u>Mus musculus</u>	U	R		0.8%
<u>Saimiri bernensis</u>	EX	R		0.8%

Table 7. A comparison of the bats of Parc National La Visite and Parc National Pic Macaya. (NC= not collected; O= observed).

Taxon	<u>La Visite</u>		<u>Macaya</u>	
	No. individuals	% total	No. individuals	% total
Family Mormoopidae				
<u>P. quadridens</u>	NC	0	1	3
<u>P. parnelli</u>	NC	0	1	3
Family Phyllostomidae				
<u>M. redmani</u>	3	16	23	59
<u>A. jamaicensis</u>	NC	0	3	8
<u>P. haitiensis</u>	1	5	2	6
<u>P. poeyi</u>	NC	0	1	3
<u>E. sezekorni</u>	NC	0	2	6
Family Vespertilionidae				
<u>E. fuscus</u>	0=12	63	5	13
Family Molossidae				
<u>T. brasiliensis</u>	3	16	1	3
Total # of individuals	19		39	

TABLE 8

Mammals of the National Parks of Haiti  
(Ex = extinct; Pr = present; NP = never present)

Endemic Land Mammals

	<u>La Visite</u>	<u>Pic Macaya</u>
Order Rodentia		
Family Capromyidae		
<u>Plagiodontia aedium</u>	Pr	Pr
<u>Plagiodontia velozii</u>	Ex	Ex
<u>Plagiodontia araeum</u>	Ex	NP
<u>Isolobodon portoricensis</u>	Ex	Ex
<u>Isolobodon montanus</u>	Ex	Ex
<u>Hexolobodon phenax</u>	Ex	Ex
New genus + species	NP	Ex
Family Echimyidae		
<u>Brotomys voratus</u>	Ex	Ex
Order Primates		
Family Cebidae		
<u>Saimiri bernensis</u>	Ex	Ex
Order Insectivora		
Family Solenodontidae		
<u>Solenodon paradoxus</u>	Ex	Pr
<u>Solenodon marcanoi</u>	Ex	Pr (?)
Family Nesophontidae		
<u>Nesophontes zamicrus</u>	Ex	Ex
<u>Nesophontes hypomicrus</u>	Ex	Ex
<u>Nesophontes paramicrus</u>	Ex	Ex
Order Xenarthra		
Family Megalonychidae		
<u>Synocnus comes</u>	Ex	Ex
<u>Parocnus</u>	Ex	Ex
New Taxon	Ex	Ex
New Taxon	Ex	Ex
New Taxon	Ex	Ex
Total number of taxa	17	18
Number of surviving taxa	1	2
Number of endemics <u>not</u> found in other park	1	1

TABLE 9

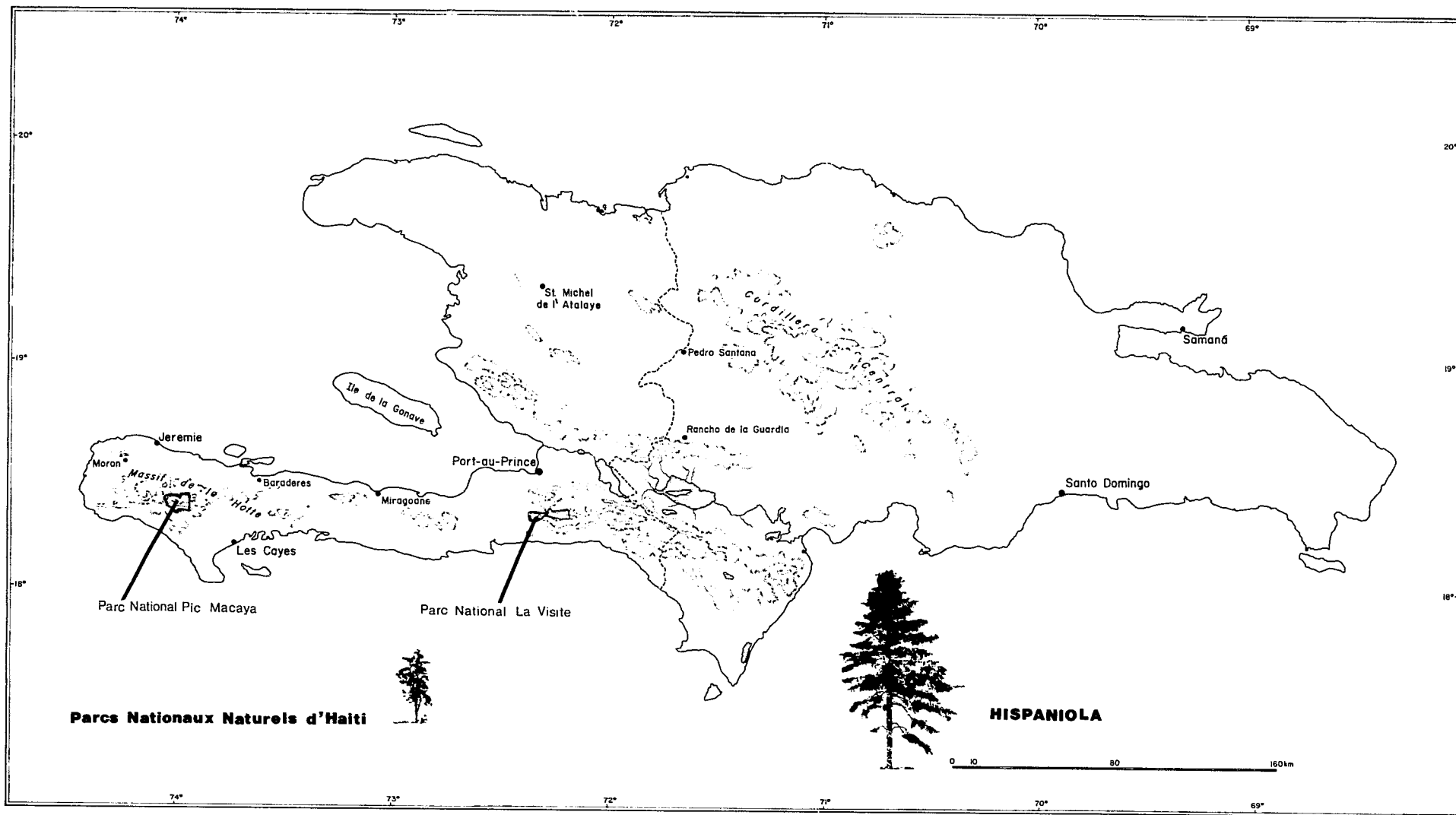
## Mammals of the National Parks of Haiti

## Introduced Land Mammals

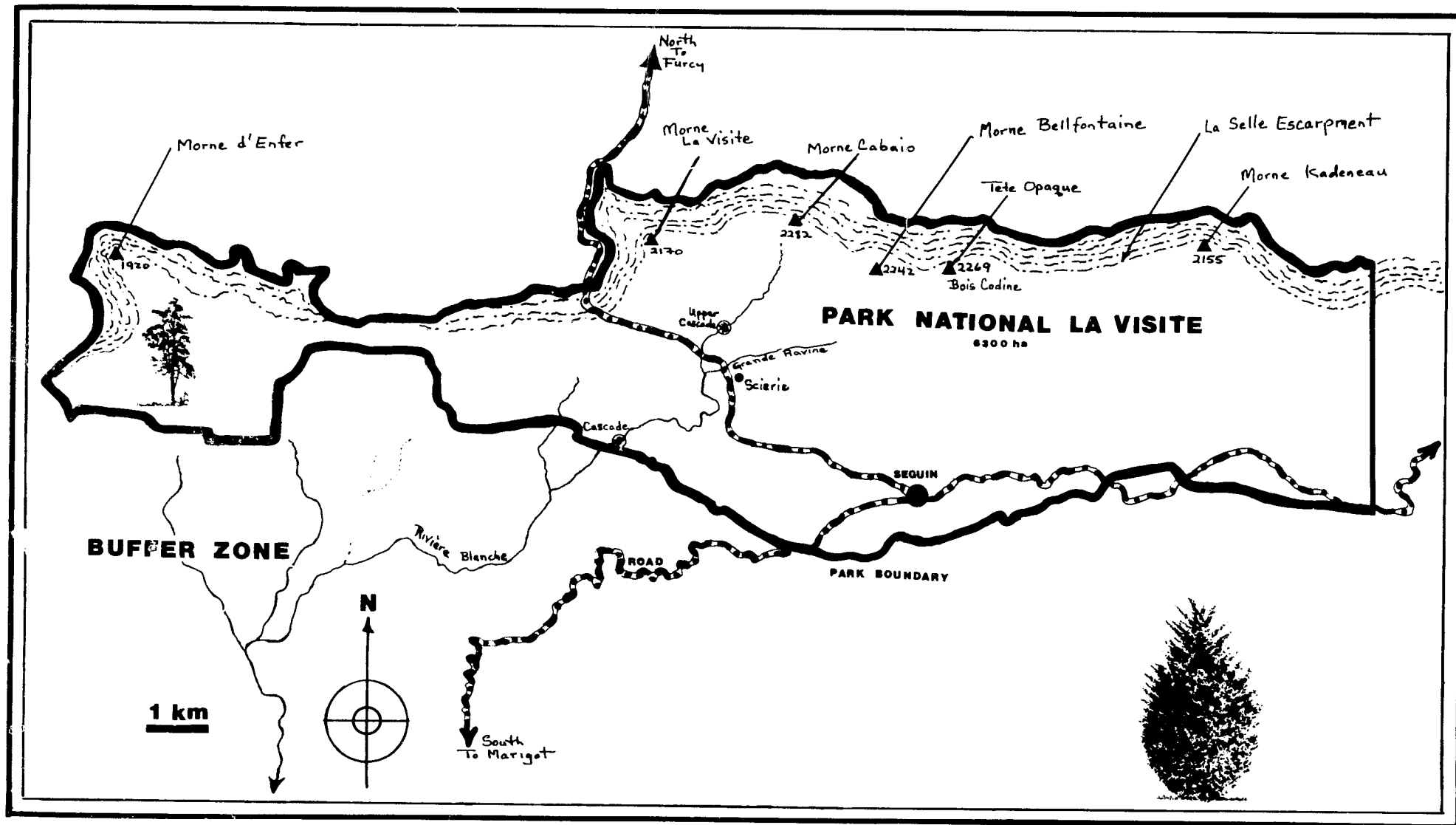
Species	<u>La Visite</u>	<u>Macaya</u>
Order Rodentia		
Family Muridae		
<u>Rattus rattus rattus</u> (Black Rat)	+	+
Brown morph		
<u>Rattus rattus rattus</u>	+	+
All grey morph		
<u>Rattus rattus rattus</u>	+	+
Grey & white morph		
<u>Rattus norvegicus</u> (Norway Rat)	+(R)	+(C)
<u>Mus musculus</u> (House mouse)	+	+
Order Carnivora		
Family Viverridae		
<u>Herpestes auropunctatus</u> (Mongoose)	+	+
Family Canidae		
<u>Canis familiaris</u> (Dog)	+(D+F)	+(D+F)
Family Felidae		
<u>Felis catus</u> (Cat)	+(D+F)	+(F)
Order Artiodactyla		
Family Bovidae		
<u>Capra hircus</u> (Goat)	+(D+F)	+(D+F)
<u>Ovis aries</u> (Sheep)	+(D)	+(D)
<u>Bos taurus</u> (Cow)	+(D)	+(D)
Order Perissodactyla		
Family Equidae		
<u>Equus caballus</u> (Horse)	+(D)	+(D)
<u>Equus asinus</u> (Donkey)	+(D)	+(D)

Present (+); common (C), domestic (D), feral (F), rare (R).

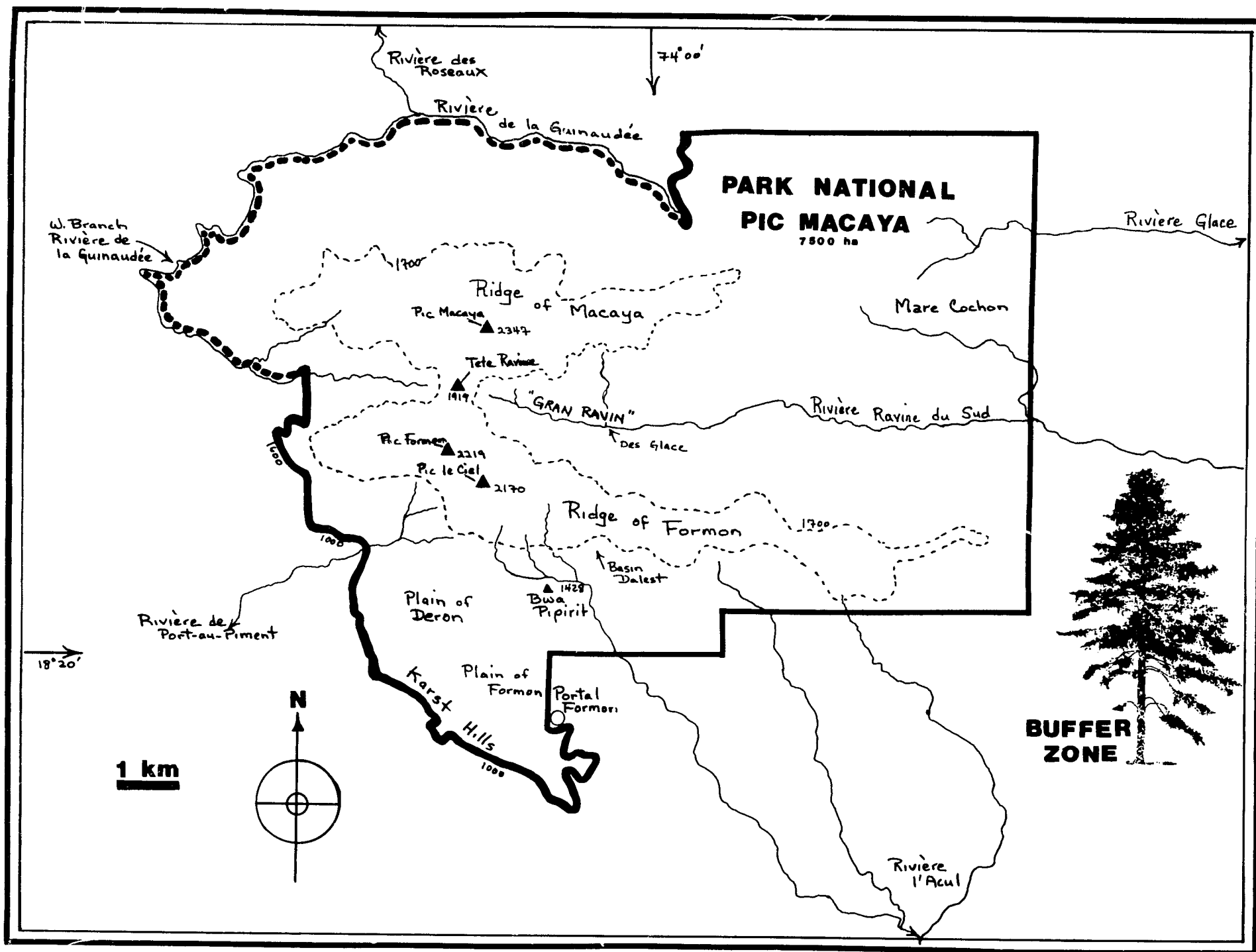
Note: feral individuals of the horse and the wild boars were observed on the slopes of Morne la Selle 18 km east of Parc National La Visite in 1984.



74



75



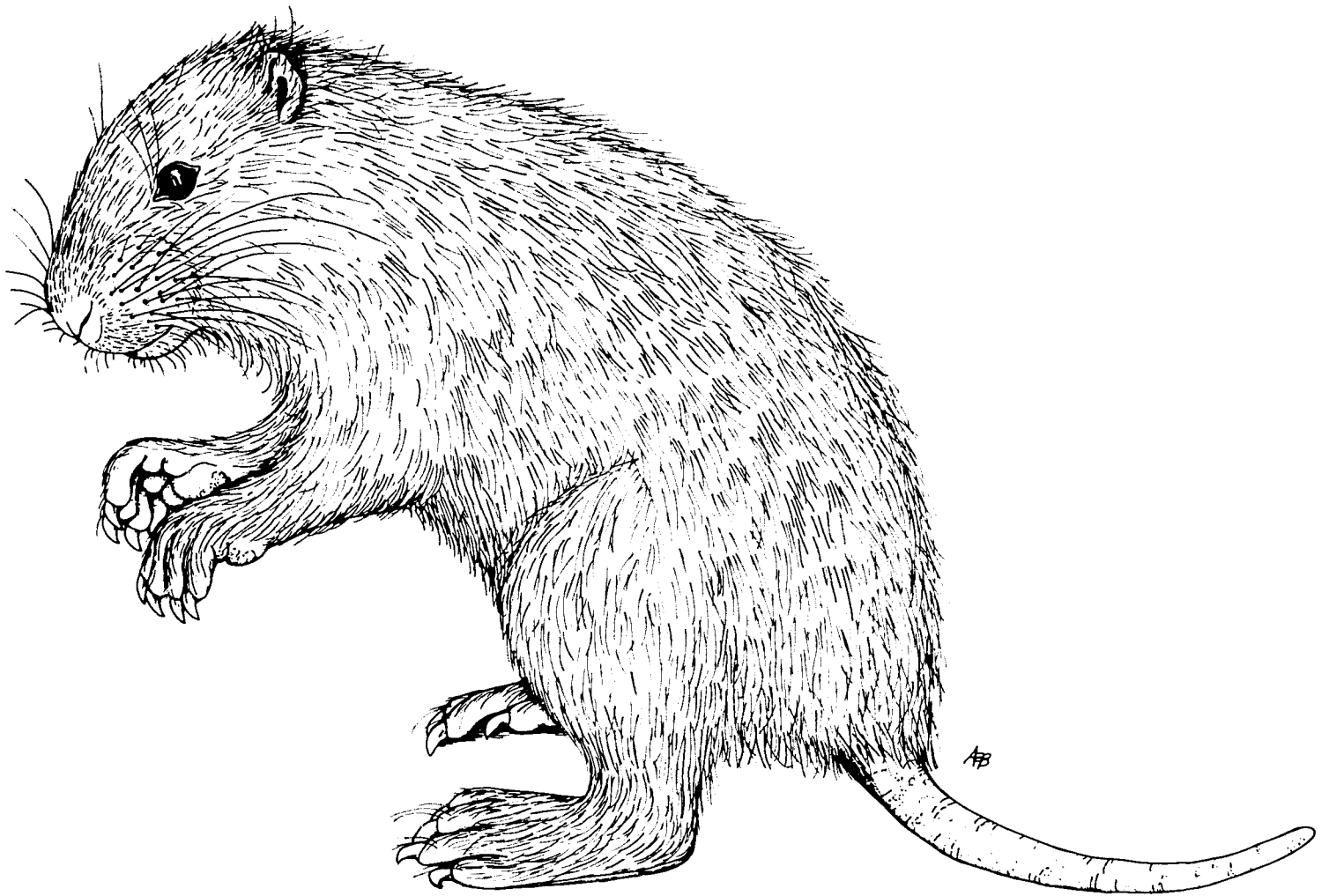


Figure 4A. *Plagiodontia aedium*

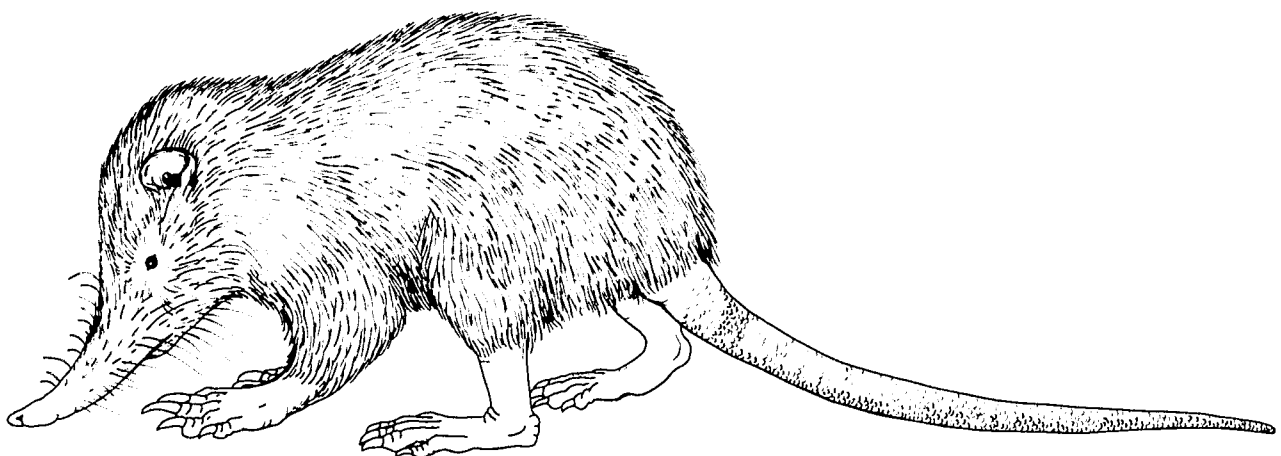


Figure 4B. *Solenodon paradoxus*



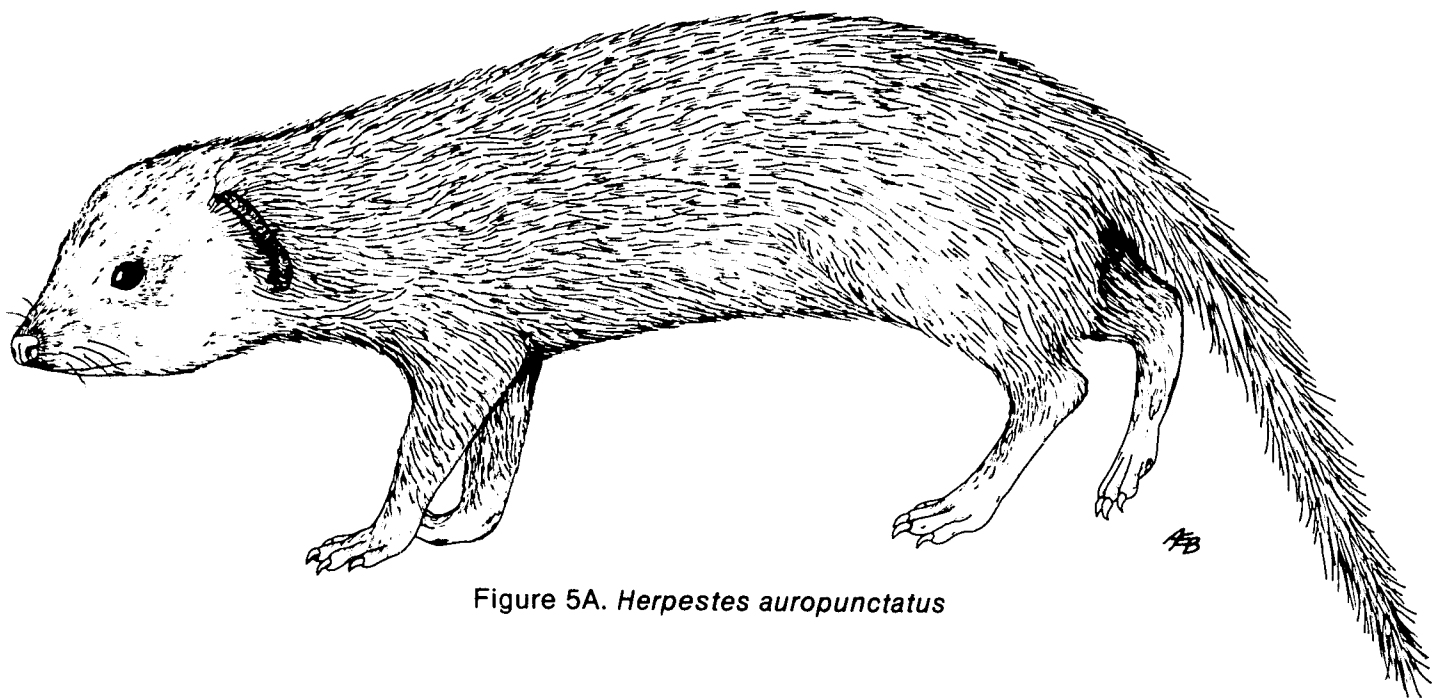


Figure 5A. *Herpestes auropunctatus*

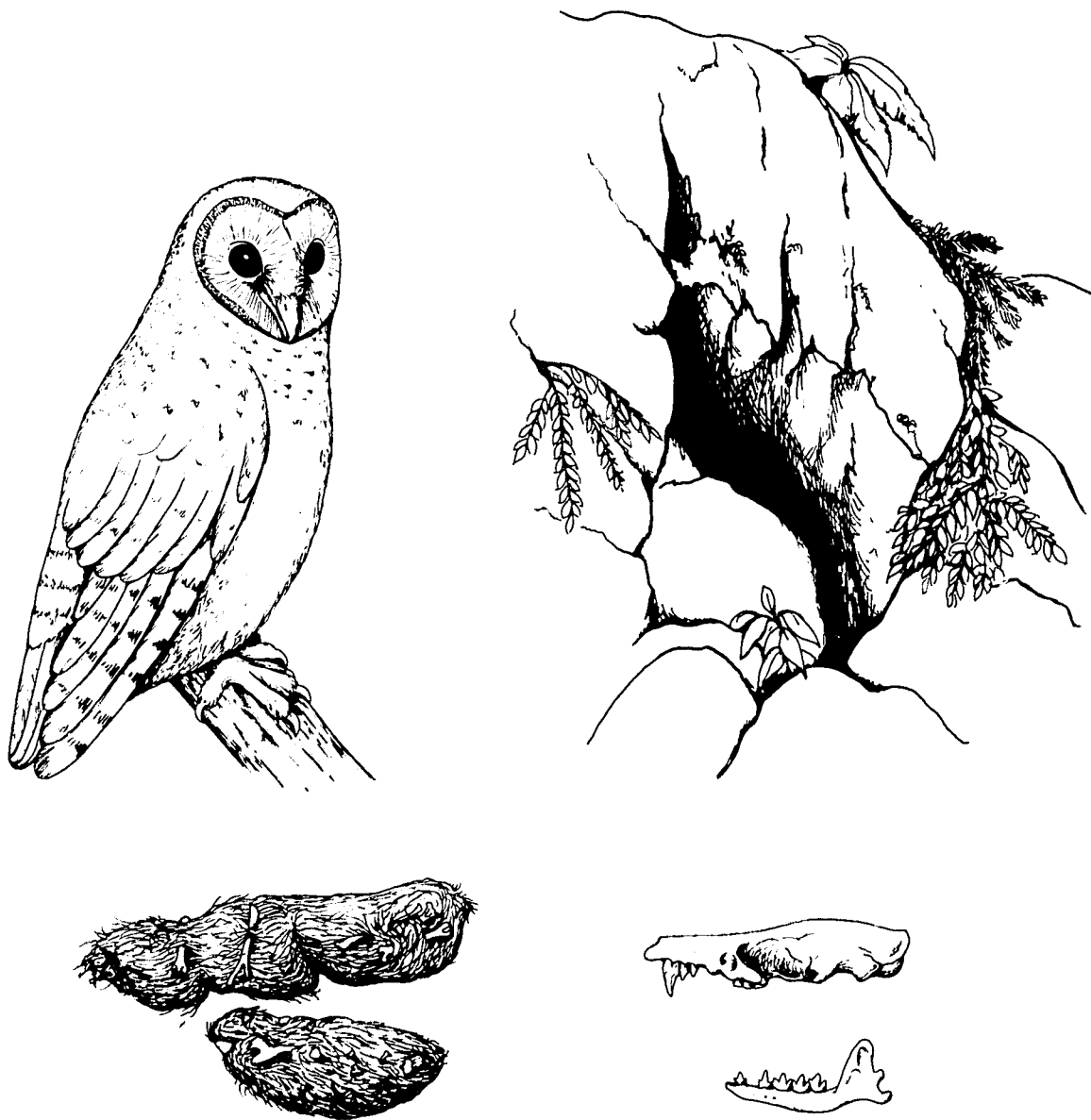


Figure 5B. Barn Owl near cave with pellet and *Nesophontes* skull



Figure 6A. *Phyllops haitiensis*



Figure 6B. *Artibeus jamaicensis*



Figure 7A. *Monophyllus redmani clinedaphus*



Figure 7B. *Phyllonycteris poeyi obtusa*